CARBON SEQUESTRATION PROGRAM ENVIRONMENTAL IMPACT STATEMENT

(DOE/EIS-0366)

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Office of Fossil Energy
National Energy Technology Laboratory

PUBLIC SCOPING REPORT

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CONTENTS

List of Tables

ACRONYMS

CAA	Clean Air Act
CO_2	carbon dioxide
DOE	(United States) Department of Energy
EIS	environmental impact statement
EOR	enhanced oil recovery
GAFS	generation available for sale
GCCI	Global Climate Change Initiative
MMV	monitoring, mitigation, and verification
NAS	National Academies of Science
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory
NGO	non-governmental organization
NOI	Notice of Intent (to prepare an EIS)
PEIS	programmatic environmental impact statement
R&D	research and development
USEPA	United States Environmental Protection Agency
WAG	water-alternating-gas

1. INTRODUCTION

This report discusses the potential environmental issues that are related to the implementation of DOE's Carbon Sequestration Program (the Program). The potential issues identified are based on meetings with personnel of the Department of Energy-National Energy Technology Laboratory (DOE-NETL), reviews of existing information on the Carbon Sequestration Program and associated elements, and comments received during the public scoping period. These issues, as well as those identified through subsequent data gathering, will be addressed in the Programmatic Environmental Impact Statement (PEIS).

The public scoping period began with a Notice of Intent (NOI) to prepare the PEIS published in the *Federal Register* on April 21, 2004 and ended on June 25, 2004. This scoping report includes the contents of comments received and categorizes the comments into five major groups:

- Need for the Proposed Action (comments on the proposed action)
- Alternatives (comments on the specific alternatives)
- Technology-Specific Concerns (comments related to technological impacts from carbon capture; geological, oceanic, and terrestrial sequestration; monitoring, mitigation, and verification (MMV); and breakthrough concepts)
- Major Initiatives (comments related to the Program's major initiatives)
- Overall Program (comments on potential impacts from the implementation of the overall Carbon Sequestration Program)

2. BACKGROUND

This section includes background information on the proposed project, i.e. the implementation of the Program, relevant to the identification of potential environmental issues as outlined in the Notice of Intent and as discussed at the public Scoping Meetings. The information and issues will be addressed in the PEIS.

Concentrations of carbon dioxide in the atmosphere have increased rapidly in recent decades, and the increase correlates with the rate of global industrialization. In 1992, the United States and 160 other countries ratified the Rio Treaty, which calls for "…stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." What constitutes an appropriate level of greenhouse gases in the atmosphere remains open to debate, but even modest stabilization scenarios would eventually require a reduction in worldwide greenhouse gas emissions of 50 to 90 percent below current levels.

Recognizing the role that carbon sequestration may play in reducing greenhouse gas emissions into the atmosphere, DOE established the Carbon Sequestration Program in 1997. Up to this point the Program has primarily been engaged in research studies, evaluations, and limited field investigations into technologies and methods for capturing and sequestering carbon dioxide. The Program received increased emphasis with the announcement on February 14, 2002 of the Global Climate Change Initiative (GCCI) by President George W. Bush. The GCCI calls for an 18 percent reduction in the carbon intensity of the U.S. economy by 2012. Technology solutions

that provide energy-based goods and services with reduced greenhouse gas emissions are the President's preferred approach to achieving the GCCI goal. The GCCI also calls for a progress review relative to the goals of the initiative in 2012, at which time decisions will be made about additional implementation measures for mitigating greenhouse gas emissions. By focusing on greenhouse gas intensity (the ratio of greenhouse gas emissions to economic output) as the measure of success, this strategy promotes vital climate change research and development (R&D) while minimizing the economic impact of greenhouse gas stabilization in the U.S.

Approximately one third of the current U.S. greenhouse gas emissions come from power plants, oil refineries, and other large point sources, and the percentage will increase in the future with a trend toward increased refining and de-carbonization of fuels. At the same time, the United States has vast forests and prairies, and is underlain by numerous significant saline reservoirs, depleted oil and gas reservoirs, and unminable coal seams that have the combined potential to store centuries of greenhouse gas emissions. Many options for CO_2 storage also have the potential to provide value-added benefits. For example, tree plantings, no-till farming, and other terrestrial sequestration practices can reduce soil erosion and pollutant runoff into streams and rivers. Storing CO_2 in depleted oil reservoirs and unminable coal seams can enhance the recovery of crude oil and natural gas, while leaving a portion of the greenhouse gas sequestered. These value-added benefits have provided motivation for near-term action and create interesting opportunities for integrated CO_2 capture and storage systems.

2.1 EIS Approach and Expected Analysis

The PEIS will be framed in a manner that focuses on the major elements of the Carbon Sequestration Program and the leading technologies within each element. Thus, the analysis of impacts will be based on the major elements and technologies to be implemented within a national and regional context while recognizing physical similarities associated with leading technologies and initiatives (e.g., geologic formations for geologic sequestration, marine environments for oceanic sequestration, contiguous forested areas for terrestrial sequestration, etc.). Also, when appropriate, cross-regional impacts may be discussed individually (e.g., impacts to specific habitats or species that extend beyond one region). Currently, there are seven regions associated with the Regional Sequestration Partnerships; however, there is some overlap between regions (some states or portions thereof are in more than one region), and the seven regions do not encompass the entire country. It is anticipated that the evaluations of impacts in the PEIS will proceed from a technology-specific impacts review, through an assessment of impacts associated with the major initiatives included in the Program, and culminating in a review of the overall impacts anticipated from the Program.

The PEIS will analyze impacts of carbon sequestration technologies and future demonstration activities programmatically and will not directly evaluate specific large-scale field demonstration projects. However, because the PEIS will evaluate issues and impacts associated with regional approaches, opportunities, and future needs for the Program, the document may result in findings that are applicable to many specific future projects and sites within a region. Hence, the PEIS will provide the basis for tiering future NEPA documents and environmental reviews for specific sequestration activities conducted by DOE and the regional partnerships. The PEIS will also set the standards for assessing cumulative impacts of site-specific projects as they relate to the Carbon Sequestration Program.

2.2 Public Scoping Activities

A series of eight public scoping meetings were held by DOE-NETL. The meeting locations spanned the U.S. and were chosen, in part, based on corresponding areas of the regional partnerships (Table 1). The meetings were announced in the NOI, advertised in four separate editions of the leading newspapers in the respective host cities, announced in press releases issued to other local media, and communicated to stakeholders by regional partners. The first of these meetings was held in Alexandria, Virginia on May 6, 2004, marking the conclusion of the Third Annual Conference on Carbon Sequestration (May 3-6, 2004, held at the same location). The last of these meetings occurred June 10, 2004 in the Grand Forks, North Dakota area. Each of these scoping meetings was preceded by an open house from 4:00 pm to 7:00 pm (5:00 pm to 7:00 pm for Bozeman, MT), during which DOE-NETL and Carbon Sequestration PEIS personnel were available to answer questions and supply handouts. Meeting agendas and presentations that described the action are provided in the Appendix.

Table 1: Carbon Sequestration PEIS Public Scoping Meetings

Meeting Location/Date	Notice Publication	Presentation Speakers	Number of Attendees*	Number of Public Speakers	Duration of Meeting
Alexandria, VA May 6, 2004	Washington Post Washington Times	Scott Klara Heino Beckert	22	0	7:00–8:30 PM
Columbus, OH May 18, 2004	Columbus Dispatch	Scott Klara Lloyd Lorenzi	12	6	7:00–8:00 PM
Chicago, IL May 19, 2004	Chicago Tribune Chicago Sun-Times	Scott Klara Lloyd Lorenzi	6	2	7:00–7:45 PM
Houston, TX May 25, 2004	Houston Chronicle	Scott Klara Lloyd Lorenzi	5	2	7:00–7:50 PM
Sacramento, CA May 27, 2004	Sacramento Bee	Sarah Forbes Lloyd Lorenzi	3	2	7:00–7:34 PM
Atlanta, GA June 2, 2004	Atlanta Journal-Constitution	Scott Klara Lloyd Lorenzi	17	2	7:00–7:48 PM
Bozeman, MT June 8, 2004	Bozeman Daily Chronicle	Scott Klara Heino Beckert	6	4	7:00–8:00 PM
Grand Forks, ND June 10, 2004	Grand Forks Herald	Sarah Forbes Heino Beckert	4	1	7:00–7:50 PM

*Note: Individuals in attendance who elected not to sign the attendance sheet are not reflected in the headcount.

Meeting attendees were requested to sign in and were given information packages that included background information on the Program, DOE-NETL, and the NEPA process. In addition, DOE-NETL provided an informational booklet, "Carbon Sequestration Technology Roadmap and Program Plan – 2004", which explains the DOE Carbon Sequestration Program. Attendees at each meeting were invited to provide written or spoken comments on the scope and issues of the Program. A sign-up sheet was provided for individuals wishing to speak. Each attendee also received a comment sheet with instructions for submission either at the meeting or before the end of the scoping period. A court recorder was present at each meeting to transcribe the meeting,

ensuring that all spoken comments were recorded (see transcripts in Appendix A). Most of the attendees at each meeting were associated with the respective regional partnerships.

DOE-NETL also provided a toll-free telephone number for members of the public who preferred to record their spoken comments, an e-mail address for those who preferred to submit their comments electronically, and a postal address for those who preferred to submit their comments via U.S. mail. Additionally, written comments were solicited through the NETL Carbon Sequestration Newsletter Listserv (the email address database). The commenting period for the scoping phase ended June 25, 2004. Three comments were submitted via e-mail and five letters were received by mail. All comments are maintained as part of the DOE/NETL Administrative Record (see Appendices F and G).

3. PROPOSED ACTION

The Proposed Action would promote the implementation of an effective Carbon Sequestration Program to support Presidential initiatives and other drivers by developing a portfolio of technologies that have great potential for the capture and sequestration of carbon. Objectives and initiatives of the Program include:

- R&D of carbon capture and sequestration technologies
- Field testing of developed technologies (both large- and small-scale)
- R&D of MMV technologies, and techniques

3.1 Major Initiatives

The Carbon Sequestration Program encompasses all aspects of carbon sequestration. The Program has engaged Federal and private-sector partners that have expertise in certain technology areas, for example, U.S. Department of Agriculture and electric utilities in terrestrial sequestration, U.S. Geologic Survey and the oil industry in geologic sequestration, the National Academies of Science in breakthrough concepts, and the U.S. EPA and NGOs in environmental issues. A strong focus is placed on direct capture of CO_2 emissions from large point sources and subsequent storage in geologic formations. These large point sources, such as power plants, oil refineries, and industrial facilities, are the foundation of the U.S. economy. Reducing net CO_2 emissions from these facilities complements efforts to reduce emissions of particulate matter, sulfur dioxide, and nitrogen oxides and represents a progression toward fossil fuel production, conversion, and use with little or no detrimental environmental impacts. In addition, MMV is emerging as an important crosscutting component for CO_2 capture and storage systems, and terrestrial offsets are a vital component of cost-effective, near-complete elimination of net CO_2 emissions from many large point sources.

The PEIS will address issues and evaluate impacts from major carbon sequestration initiatives, including the following:

Regional Partnerships

The regional diversity of CO_2 sources and storage opportunities emphasizes the need for a diverse portfolio of strategies under the Carbon Sequestration Program. DOE is engaging Federal, state, and local government agencies; non-governmental organizations; private sector participants; and the academic research community in a number of Regional Sequestration Partnerships in areas of the country that offer potential opportunities for CO_2 capture and storage. These partnerships are screening the respective regions for significant CO_2 sources and promising storage options, and they will establish necessary MMV protocols. The partnerships will also promote the development of infrastructure needed to validate and deploy sequestration technologies, and they will address the regulatory, environmental, and outreach issues associated with priority sequestration opportunities in the region. Through the Regional Sequestration Partnerships, DOE established the following objectives:

- Initiate 7 cost-share projects (completed in 2004)
- Phase II awards for technology validation (by 2006)
- Conduct numerous small-scale field validation tests (2006 – 2013)

Monitoring, Mitigation, and Verification (MMV) Program

MMV is an essential element of the Carbon Sequestration Program and the proposed Regional Sequestration Partnerships that relates to all aspects of capture and sequestration. DOE established the following objectives for MMV:

- By 2006, apply promising MMV technologies to at least several sequestration field tests or commercial applications.
- By 2008, an MMV protocol enables 95 percent of CO_2 uptake in a terrestrial ecosystem to be credited and represents no more than 10 percent of the total sequestration cost.
- By 2012, an MMV protocol enables 95 percent of CO_2 injected into a geologic reservoir to be credited and represents no more than 10 percent of the total sequestration cost.

Collaboration with National Academies of Science (NAS)

NAS conducted a workshop in 2003 to identify R&D opportunities for breakthrough concepts advancing carbon sequestration. DOE used the results of the workshop for a solicitation for R&D projects that were selected by the Program. When proposals were received, an NAS committee evaluated the scientific, technical, engineering, and environmental merits of each. Through this collaborative effort, DOE established the following objectives:

- Award multiple R&D projects (completed in 2004)
- Potential demonstration of 2 projects at the laboratory-scale (by 2007)
- GCCI technology assessment of at least one breakthrough concept (by 2012)

FutureGen

FutureGen, the Integrated Sequestration and Hydrogen Research Initiative, is a $1 Billion government/industry partnership to design, build, and operate a nearly emission-free, coal-fired electric and hydrogen production plant. The prototype plant will serve as a large-scale engineering laboratory for testing new clean power, carbon capture, and coal-to-hydrogen technologies. It is intended to be the cleanest fossil fuel-fired power plant in the world.

Virtually every aspect of the prototype plant will employ cutting-edge technology. With respect to sequestration technologies, captured CO_2 will be separated from the hydrogen perhaps by novel membranes currently under development. It would then be permanently sequestered in a geologic formation. Candidate reservoir(s) could include depleted oil and gas reservoirs, unminable coal seams, deep saline formations, and basalt formations – all common in the U.S. FutureGen efforts will benefit from the other ongoing activities in NETL's Carbon Sequestration R&D portfolio. Although FutureGen is a component of the Carbon Sequestration Program, the project will be addressed by a separate NEPA document.

3.2 Need for Agency Action

The Proposed Action is needed to support the implementation of an effective Carbon Sequestration Program by DOE in order to advance the goals of the GCCI and National Energy Policy. To achieve these objectives, the Program needs to consider, evaluate, develop, and implement carbon capture and carbon storage technologies, including effective monitoring, mitigation, and verification methods, over a longer-range planning horizon. The Program is also needed to provide technological viability data for the GCCI 2012 technology assessment.

The programmatic timeline intends to demonstrate a series of safe and cost-effective carbon capture and carbon storage technologies at a commercial scale by 2012, if needed, with potential deployment leading to substantial market acceptance beyond 2012. Wide-scale deployment of these technologies holds great promise to slow the growth of greenhouse gas emissions in the near-term while ultimately leading to a stabilization of emissions toward the middle of the 21st century. As R&D concepts are now beginning to approach the point of field-testing, there is a critical need to perform a PEIS in advance of these activities in accordance with established DOE NEPA procedures.

3.3 Public Comments on the Proposed Action

Many respondents associated with regional partnerships provided comments supporting the Carbon Sequestration Program. However, some respondents expressed concern about whether this program may promote the use of coal and other CO_2-emitting fuels. These respondents believe that the focus of energy strategies should be on encouraging the development and use of renewable resources, such as wind and solar energy. Comments related to the proposed action and need are summarized below:

Table 2: Public Comments on the Proposed Action

Comment	How and Where Addressed in EIS
Need for Proposed Action	
1. Concern about the Program promoting the continued use of high CO_2-emitting fuels – PEIS should document the need for the Program.	Chapter on Purpose and Need The PEIS will emphasize that carbon sequestration is one of three principal approaches (pillars) for managing carbon emissions into the future. The others are (1) reducing carbon intensity (through renewable energy sources, nuclear energy, and fuel switching) and (2) improved energy efficiency (demand-side conservation and supply-side technological advancements). The PEIS will not promote carbon sequestration at the expense of the other approaches but will emphasize that all three pillars are needed.

4. ALTERNATIVES

4.1 Description of Alternatives

DOE has indicated that alternatives will include at a minimum the Proposed Action and No Action. Under the Proposed Action, DOE would proceed in a focused and accelerated manner to implement the Carbon Sequestration Program on a broad front, including the identification, demonstration and deployment of promising technologies for: carbon dioxide capture; sequestration (geologic, oceanic, and terrestrial); monitoring, mitigation, and verification; and breakthrough concepts on a regional and national scale. DOE would pursue a program of providing and supporting decisions for meeting the President's GCCI goal of an 18 percent reduction in the carbon intensity of the U.S economy by 2012. Under the No Action alternative, the Carbon Sequestration Program would continue along a path comparable to the level of previous research studies, evaluations, and field investigations. However, in contrast to the Proposed Action, the No Action Alternative would approach carbon sequestration in a less focused manner and at a much slower pace, translating into a less intensive approach to all aspects of carbon sequestration activities in the U.S.

As subsets of the Proposed Action, additional alternatives may emerge during scoping and further development of the PEIS. Such alternatives might include varied schedules for implementation of Program components, alternative technologies or variations in the mix of technologies to achieve objectives, variations in the implementation of sequestration methods, variations in implementation by geographic region, and other possibilities. Furthermore, DOE may use the PEIS findings with respect to potentially significant issues and impacts in its decision-making process for selecting technologies to be demonstrated and deployed, as well as for establishing the timetable for implementation. Therefore, various subsets or combinations of actions may be available to the decision-making process that would negate the selection of technologies or processes associated with potentially significant and unavoidable adverse impacts. The PEIS might also indicate technologies that appear critically flawed or that may have serious and unpredictable impacts, which would preclude them from further consideration as part of the Proposed Action.

Finally, the PEIS will provide the framework for future technology assessment and field studies for the identification of new Program needs and future directions for carbon sequestration efforts. As a programmatic document, the PEIS will indicate issues and potential impacts that would be evaluated more closely in site-specific environmental studies for project-specific NEPA documents.

4.2 Public Comments on the Alternatives

Most respondents suggested objectives and approaches that the Program should take. Some suggested that funding and support should be significant for DOE's efforts in coal-based R&D – these comments were mostly offered by participants of the regional partnerships in locations having substantial coal resources and existing coal-based power plants in search of carbon capturing technologies. Others supported the use of combined strategies, promoted wider public participation, and recommended land management as a strategy for carbon emissions reductions. Several comments were directed specifically at DOE-NETL's "Carbon Sequestration

Technology Roadmap and Program Plan – 2004," which was provided during the public scoping meetings. Comments on alternatives are summarized below:

Table 3: Public Comments on the Alternatives

Comment	How and Where Addressed in EIS
1. Achieving meaningful reductions of CO2 will require a combined approach, including cost-effective control technologies, increased fuel efficiency, lower emitting and renewable sources, advanced electro-technologies, terrestrial sequestration and other land management methods, geological sequestration, and a market-based training program.	See response to Comment 1 in Table 2.
2. Technology development should be based on fuel-specific applications important for a particular region. For example, Ohio's abundance of coal and its support for FutureGen - this would support the economic/infrastructure development sensible for that region.	Chapter on Proposed Action and Alternatives The PEIS will recognize that alternative technologies for carbon sequestration may be feasible or more efficient in some areas and not others.
3. DOE should continue to provide support for regional efforts in the development of energy for infrastructure, not just for carbon sequestration R&D, but infrastructure development at large.	Chapter on Purpose and Need The PEIS will explain that the scope of the Carbon Sequestration Program does not extend to supporting general infrastructure development unrelated to carbon sequestration approaches. Other Federal programs under DOE and other agencies may provide support for such needs.
4. Due to rising gas costs there is an increasing interest in coal use. Promoting coal use would reduce US dependence on imported fuel sources. DOE should focus on basic coal R&D programs. Funding should go towards concerns associated with combustion facilities.	See response to Comment 3 above. Other DOE programs are involved with basic coal combustion R&D.
5. Remember the smaller units – there is increasing interest for smaller generators – many wanting to environmentally upgrade the mid-and small-sized units.	Chapter on Purpose and Need The PEIS will explain that the Carbon Sequestration Program is not targeted at particular generators, but that it is considering technologies that may be applicable to a broad range of facilities without specific regard for size.
6. Bulk of funding should go for controls that are added onto large CO2 emitters like coal-fired power plants or oil-fired boilers.	See response to Comment 5.
7. Regarding the role of the Program in addressing problems on both a national and global scale, the power industry needs a full demonstration of capture and sequestration technologies.	Chapter on Purpose and Need The PEIS will explain that the Carbon Sequestration Program intends to promote and support the demonstration of a full range of carbon capture and sequestration technologies in partnership with industries, Federal agencies, and state and local governments.
8. Sequestration could be as simple as to evaluate land use and what practices are being used.	Chapter on Proposed Action and Alternatives The PEIS will address land use practices as components of terrestrial sequestration approaches.
9. In order for MMV to succeed, it should be kept simple.	Chapter on Proposed Action and Alternatives The PEIS will consider the potential problems associated with MMV from the perspectives of both accuracy and manageability.
10. Any policies designed to address global climate change should provide flexibility in meeting emission reduction goals and include reasonable compliance schedules to encourage the development of realistic, cost-effective control technologies, while recognizing climate change is a global issue. They should provide incentives for technological developments and also recognize and allow the registration for early actions that have already been taken.	Chapter on Purpose and Need The Carbon Sequestration Program provides technology options for policymakers. The Program will evaluate key approaches for addressing carbon emissions as a factor in global climate change by demonstrating various technologies that have potential to achieve this goal.
11. DOE should consider financial and technical support for efforts already underway to develop cost-effective and credible means for auditing and verifying the carbon units that are recorded in a transactional registry (Georgia has set a framework in place for recording transactions of sequestered carbon from agricultural and forest products.)	Chapter on Proposed Action and Alternatives The PEIS will discuss efforts that are underway to verify carbon unit reductions as a component of MMV technologies.

Comment	How and Where Addressed in EIS
12. The entire Program assumes that we continue to use coal, oil, and natural gas as the primary fuels for many decades to come. There should be a parallel strategy – a carbon-free hydrogen economy (support wind, solar and hydrogen fuel cells to meet power demands).	See response to Comment 1 in Table 2. The scope of the Carbon Sequestration Program does not encompass the potential for a carbon-free economy, which is addressed by other programs within DOE and other Federal agencies.
13. Focus on energy efficiency improvements in power generation, transportation and buildings.	See response to Comment 1 in Table 2.
14. Should focus more on the idea of not leaving an emissions legacy for future generations to clean up.	See response to Comment 1 in Table 2.
15. Funding for technology is essential and should be approached as a 3-way endeavor Federal/state/industry effort.	See response to Comment 7 above.
16. Combine efforts and work with other organizations that may have similar goals. For example, agencies that protect and give value to a public land base (goal is to benefit public, fish and wildlife, but can also benefit carbon sequestration goals).	See response to Comments 7 and 8 above.
17. When evaluating and developing recommendations relative to accounting rules, should assess concurrent restoration benefits and the environmental acceptability of the sequestering methods. Evaluate the linkage between federal conservation programs and carbon sequestration and establish benchmark standards for future carbon programs.	Chapter on Proposed Action and Alternatives The PEIS will consider and assess concurrent restoration benefits and the environmental acceptability of the sequestering methods.
18. Stressed importance of maintaining a public dialogue – public must understand in order to gain their support and participation, so keep language accessible (i.e., public meeting materials, etc.)	This recommendation will be taken into consideration throughout the development of the PEIS.
19. Need to have a lot of public outreach into the non-traditional communities (i.e., Native Americans, rural, etc.).	DOE will make greater outreach efforts to non-traditional communities for review of the Draft PEIS.
20. True success only if international community is allowed to participate.	The Carbon Sequestration Program has international involvement, including the Carbon Sequestration Leadership Forum (CSLF), an international climate change initiative. The CSLF consists of 16 countries with the goals of developing carbon capture and storage technologies as a means to accomplishing long-term stabilization of greenhouse gas levels in the atmosphere, and participating in the International Energy Agency's Greenhouse Gas Programme. Regional partnerships extend into Canada, and the Program is monitoring technological approaches implemented in other nations. However, the PEIS is being prepared under the jurisdiction of NEPA, which is a U.S. Federal law.
21. Would like to see a real linkage of the outreach and research to the regulatory and compliance issues. Real coordination between EPA and DOE is needed in this area.	Chapter on Proposed Action and Alternatives The PEIS will review relationships between regulatory and compliance issues and the relationship between the responsibilities of EPA and DOE in this regard.
22. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Page 4 – the prediction of CO2 storage capacity is an accuracy of plus/minus 30% and program should have a goal of plus/minus 15%.	Chapter on Proposed Action and Alternatives – DOE will determine whether the proposed standards for measurement accuracy are feasible and will make changes as appropriate, which will be reflected in the PEIS.
23. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Page 15, Table 4 (MM&V row) – 5-30% accuracy is not good enough. DOE should set a goal of 5-15% for current on-the-ground measurements accuracy.	See response to Comment 22 above.
24. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Page 19, Regional Partnerships – DOE states that it expects that the regional partnerships will become self-sustaining. Concerned that this criterion would be detrimental to the appropriate research – focus would become more on funding rather than on science.	Chapter on Proposed Action and Alternatives – DOE's ability to fund regional partnership initiatives and demonstrations will be limited by Federal budgetary decisions. DOE will take the recommendation into consideration in accordance with this constraint.

Comment	How and Where Addressed in EIS
25. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Meeting materials – entire document is difficult to read for the ordinary citizen – EIS should be easy to understand.	This recommendation will be taken into consideration throughout the development of the PEIS.
26. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Page 4 - What is meant by silviculture practice? Do not support logging of mature and older growth forests and the use of monoculture plantations as acceptable silviculture practices.	Chapter on Proposed Action and Alternatives The PEIS will discuss silviculture practices associated with terrestrial sequestration.
27. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Page 4 - DOE must reveal to public what loss of 5% of CO_2 means in tons of CO_2 emissions. If storage area is large, this could be a considerable amount of CO_2 not captured; 95% of emissions reduction may not be adequate.	Chapter on Proposed Action and Alternatives DOE will determine whether CO_2 emissions capture greater than 95% is feasible, which will be reflected in the PEIS.
28. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Page 13 - "optimizing silvicultural practices for degraded lands" – define what this means and what it includes	Chapter on Proposed Action and Alternatives See response to Comment 26 above.
29. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Page 13 – "Enhanced carbon transfer from plant to soil." - define what this means and what it includes.	Chapter on Proposed Action and Alternatives The PEIS will define this concept relative to the Program.

5. TECHNOLOGY-SPECIFIC IMPACTS

5.1 CO_2 Capture

Impacts associated with the application of technologies for CO_2 capture would be primarily located at large point sources, including power plants, oil refineries, and industrial sites.

Technologies

- Pre-combustion Decarbonization
- Oxygen-Fired Combustion
- Post-Combustion Capture
- Advanced Conversion/Chemical Looping

Context

- National
- Regional (All - any region with large CO_2 point sources)

Issues and Impact Areas

Potential impacts anticipated from the development, demonstration, and implementation of CO_2 capture technologies would primarily be related to the addition of new facilities (e.g., equipment, pipelines, utility corridors, etc.), industrial processes, the additional use of materials and chemicals, and the resulting potential for environmental releases (e.g., additional waste streams, air emissions, etc.). Many of these impacts are expected to be site-specific in nature and associated with particular future demonstrations and implementation projects. These site-specific and project-specific impacts would be addressed in future NEPA and other environmental documents prepared for site-specific actions. The PEIS will assess the general

range and types of potential impacts that can reasonably be expected to occur from these types of activities in regions where the technologies are applicable, as well as any national effects. It is recognized that the there can be differences in potential impacts from region to region for the same technology. To the extent reasonable and possible, the PEIS will acknowledge and discuss these regional differences.

Specific issues and impacts that the PEIS is expected to address and analyze include:

- ***Atmospheric Resources*** – Technologies employed to capture CO_2 may affect the emission of criteria air pollutants that are regulated under the Clean Air Act (CAA). The six criteria air pollutants for which the USEPA has established national ambient air quality standards are carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide. CO_2 capture technologies are expected to reduce the net rate of greenhouse gas emissions. However, although net greenhouse gas emissions may be reduced, some unregulated emissions may increase (mercury, ammonia, etc.).
- ***Aesthetic and Scenic Resources*** – Facilities constructed for CO_2 capture and conveyance (e.g., pipelines) may affect scenic resources and aesthetics in the vicinities of the sites selected. Increases in facility size, footprint, and visibility to support capture-related technologies added to existing facilities may also affect aesthetics and scenic resources.
- ***Biological Resources and Protected Species*** – The potential for impacts on vegetation, wildlife habitats, wildlife, and species protected under the Endangered Species Act would be related primarily to land-disturbing activities associated with the construction, operation and maintenance of CO_2 capture and conveyance systems (e.g., pipeline and utility corridors).
- ***Cultural Resources*** –The potential for impacts on cultural resources would be related primarily to land-disturbing activities during construction of CO_2 capture and conveyance systems, as well as to effects on historic vistas caused by incompatible structures.
- ***Land Use*** – The addition of systems for CO_2 capture and conveyance to existing facilities may affect the footprints of these sites and cause impacts on land use, as would the siting of new facilities. Impacts on land use also would relate to the cumulative extent of land requirements for CO_2 capture facilities implemented on a regional and national scale.
- ***Materials and Waste Management*** – Potential impacts on materials and waste management would relate to possible increases in requirements for fuels, raw materials, and chemicals (solvents) and increases in the respective solid and liquid waste streams of CO_2 capture technologies.
- ***Human Health Effects and Safety*** – Potential health and safety effects may result from emissions, hazardous materials, and process waste streams for CO_2 capture facilities. Potential health and safety impacts may also result from a catastrophic release of captured CO_2. The significance of impacts would be influenced by regional variations in human population density and the proximity of potential facilities for CO_2 capture to populated areas.
- ***Socioeconomics*** –The energy demands by technologies and equipment for CO_2 capture and conveyance systems may affect the efficiency and capacity for net energy generation when the Program is implemented on a regional and national scope. Impacts may also be

associated with potential emissions trading credits (or allowances) afforded by a future carbon emission commodity market (see Monitoring, Mitigation, and Verification).

- ***Utility Infrastructure*** – Impacts may result from the increased energy demands by facilities for CO_2 capture that reduce the energy generation available for sale (GAFS). Potential impacts may also be associated with pipelines required to transport captured CO_2 to sequestration facilities. The significance of potential impacts would be influenced by regional variations in the distance of facilities for CO_2 capture from sequestration sites.
- ***Water Resources and Water Quality*** – Potential impacts would relate to the requirements for water consumption and wastewater disposal by CO_2 capture facilities and the effects of implementation of the Program on a regional and national scale. The significance of potential impacts would vary regionally according to the availability and dependability of the water supply and its ability to assimilate wastewater effluents.

5.2 Sequestration

5.2.1 Sequestration – Geologic

Geologic sequestration would include technologies to inject captured CO_2 into various geologic formations.

Technologies

- Depleted oil reservoirs (enhanced oil recovery [EOR] and natural gas production)
- Unminable coal seams
- Saline Formations
- Other geologic formations

Context

- National
- Regional (regions having suitable formations and reservoirs)

Issues and Impact Areas

Potential impacts anticipated from the development, demonstration, and implementation of geologic sequestration technologies would be related primarily to the construction and operation of facilities (e.g., equipment, pipelines, utility corridors, etc.), industrial processes, the additional use of materials and chemicals, the resulting potential for environmental releases (e.g., additional waste streams, air emissions, etc.), and unpredicted effects on selected geologic formations. Many of these impacts are expected to be site-specific in nature and associated with particular future demonstrations and implementation projects. These site-specific and project-specific impacts would be addressed in future NEPA and other environmental documents prepared for site-specific actions. Impacts attributable to geologic sequestration technologies may occur in regions of the country where suitable geologic formations are available for the potential implementation of these technologies. Therefore, the PEIS will assess the general range and types of potential impacts that can reasonably be expected to occur from these types of activities in regions where the technologies are applicable, as well as any national impacts.

Specific issues and impacts that the PEIS is expected to address and analyze include:

- ***Atmospheric Resources*** – Emissions associated with construction and drilling activities for geologic sequestration on a regional or national scale, including the release or burning of subsurface gases, may cause potential impacts on air quality. Ambient air quality standards for criteria air pollutants (carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide) also may be affected by emissions from compressor stations required to inject CO_2 into suitable geologic formations.
- ***Aesthetic and Scenic Resources*** – The construction and operation of facilities and conveyance systems (pipelines) to support geologic sequestration may affect scenic resources, vistas, and aesthetics in the vicinities of the sites selected.
- ***Biological Resources and Protected Species*** – The potential for impacts on vegetation, wildlife, wildlife habitats, and species protected under the Endangered Species Act would be related primarily to land-disturbing activities, such as road-building and pipeline placement, during construction of facilities to support geologic sequestration. Additional impacts on protected species may result from the operation and maintenance of these facilities; especially pipeline routes and utility corridors.
- ***Cultural Resources*** – Potential impacts on cultural resources may result from land-disturbing activities during construction of roads and support facilities for geologic sequestration, as well as from effects on historic vistas caused by incompatible structures.
- ***Land Use*** –New facilities, such as pumping stations and pipelines, and conveyance corridors needed to support geologic sequestration may affect land use. The potential for changes in commercial and industrial development patterns also may exist in areas considered suitable for geologic sequestration.
- ***Materials and Waste Management*** – Potential impacts on materials and waste management would relate to possible increases in requirements for fuels, raw materials, and chemicals (solvents) and increases in the respective solid and liquid waste streams of facilities and processes needed to support geologic sequestration projects.
- ***Human Health Effects and Safety*** – Health and safety concerns may result from construction activities, well drilling activities, the management of hazardous materials and chemicals, and the management of stored or released gases in conjunction with geologic sequestration. Additional impacts on human health and safety may be caused by a potential catastrophic release of stored gases, or the leakage of sequestered gases after long-term saturation of geologic formations.
- ***Socioeconomics*** – Increases in production of domestic oil, natural gas, and coal-bed methane resulting from geologic sequestration activities may have economic impacts on producers and consumers. Increased costs of fossil energy use may also have economic impacts on producers and consumers. Environmental justice issues may be associated with the siting of sequestration projects.
- ***Utility Infrastructure*** – Impacts may result from CO_2 conveyance requirements and the need for intermediate storage facilities to dampen CO_2 load fluctuations and ensure a constant CO_2 supply to geologic sequestration sites and market end users (e.g., EOR).

- ***Water Resources and Water Quality*** – Various activities and conditions associated with geologic sequestration may have impacts on water resources, including water requirements for water-alternating-gas (WAG) CO_2 injection; brine migration via hydrologic fractures and/or leaking well seals; crude oil leakage; increased methane gas in coal seam outcroppings; leakage due to formation dissolution; mobilization of heavy metals; increased produced water and disposal impacts; potential for contamination of aquifers used as drinking water supplies; potential for degradation of groundwater quality associated with construction and operational activities (e.g., injection of tracer chemicals); and a range of potential surface water quality impacts related to industrial discharges associated with sequestration facilities and activities (e.g., drilling fluids management).
- ***Soils*** – Impacts on soils may result from potential CO_2 saturation and leakage at sequestration sites. Soils also may be contaminated as a result of compression equipment fluids handling (refer to Materials and Waste Management).
- ***Geology*** – The injection of CO_2 into geologic formations by sequestration projects may result in hydrologic fractures in the formations affecting local aquifers. CO_2 injection into geologic formations may present seismic hazards.

5.2.2 Sequestration – Oceanic

Oceanic sequestration would involve either the injection of CO_2 into the ocean or the enhancement of CO_2 uptake by marine ecosystems. Oceanic sequestration is in a much earlier stage of development than geologic and terrestrial sequestration. Although oceans have a great capacity for carbon storage, the scientific understanding of ocean sequestration mechanisms and their effects on marine ecosystems is currently not well established. Research in this area is further complicated by an incomplete understanding of the "natural" fluctuations in the sink/source nature of CO_2 in the ocean. Therefore, this pathway is the subject of ongoing studies, and the level of detail for the analysis of impacts must be tailored accordingly.

Technologies

- Ocean Injection
- Ocean Fertilization

Context

- Oceans adjacent to US shores
- High Seas

Issues and Impact Areas – Ocean Injection

The development, demonstration, and implementation of ocean CO_2 injection technologies may have potential land- and ocean-based impacts. Land-based impacts would be related primarily to the construction and operation of supporting facilities (e.g., equipment, pipelines, utility corridors, etc.), industrial processes, the use of materials and chemicals, and the resulting potential for environmental releases (e.g., additional waste streams, air emissions, etc.). Ocean-based impacts would be related to the construction and operation of ocean platforms for CO_2 injection facilities and underwater CO_2 conveyance facilities, as well as the effects of introducing large quantities of CO_2 into marine ecosystems. Many of these impacts are expected to be site-

specific in nature and associated with particular future demonstrations and implementation projects. These site-specific and project-specific impacts would be addressed in future NEPA and other environmental documents prepared for site-specific actions. Potential impacts attributable to ocean CO_2 injection technologies may occur in suitable coastal areas of the United States. Therefore, the PEIS will assess the general range and types of potential impacts that can reasonably be expected to occur from ocean CO_2 injection activities in coastal environments and marine ecosystems.

Specific issues and impacts that the PEIS is expected to address and analyze include:

- ***Atmospheric Resources*** – Ambient air quality standards for criteria air pollutants (carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide) may be affected by emissions associated with construction and operation of facilities for ocean injection (e.g., ocean platforms, CO_2 compression equipment, conveyance systems, etc.).
- ***Aesthetic and Scenic Resources*** – Facilities and conveyance systems constructed to support ocean injection may affect scenic resources, vistas, and aesthetics in the vicinities of sites selected.
- ***Biological Resources and Protected Species*** – Impacts on terrestrial and marine vegetation, fish and wildlife habitats, and species protected under the Endangered Species Act and Marine Mammal Protection Act may result from the construction, operation, and maintenance of land- and ocean-based facilities for CO_2 injection. Ocean injection of CO_2 may cause changes in aquatic chemistry and affect populations of phytoplankton, zooplankton, vegetation, vertebrates, and invertebrates in marine ecosystems.
- ***Cultural Resources*** –Impacts on cultural resources may result from construction of facilities for ocean injection (CO_2 compression equipment, conveyance systems, etc.), as well as from effects on historic vistas caused by incompatible structures. Native American groups may experience or perceive impacts on fishing, cultural values, and traditional uses of marine resources depending upon project locations.
- ***Land Use*** – New facilities, such as pumping stations and pipelines, and conveyance corridors needed to support ocean CO_2 injection may affect land use. The potential for changes in commercial and industrial development patterns also may exist in areas considered suitable for ocean CO_2 injection.
- ***Materials and Waste Management*** – Potential impacts on materials and waste management would relate to possible increases in requirements for fuels, raw materials, and chemicals (solvents) and increases in the respective solid and liquid waste streams of facilities and activities needed to support ocean CO_2 injection projects.
- ***Human Health Effects and Safety*** – Health and safety concerns may result from the construction of facilities, the management of hazardous materials and chemicals, and the management of stored CO_2 in conjunction with ocean CO_2 injection. Unanticipated impacts on human health and safety may be caused by a possible catastrophic release of stored CO_2.
- ***Socioeconomics*** – Socioeconomic impacts may result from potential adverse effects on fishing (commercial and recreational) and tourism attributable to ocean CO_2 injection

practices. Potential environmental justice issues may be associated with the siting of ocean injection support facilities.

- ***Utility Infrastructure*** –Impacts may result from CO_2 conveyance requirements, such as pumping stations and pipelines. Impacts on infrastructure also may occur from the utility needs of support facilities and ocean platforms.
- ***Water Resources and Water Quality*** – Various activities and conditions associated with ocean CO_2 injection may have impacts on water resources, including potential changes in aquatic chemistry (e.g., pH) from intensive injection of CO_2 and potential contamination from spills or leaks of fuels and solvents at injection facilities.

Issues and Impact Areas – Ocean Fertilization

The development, demonstration, and implementation of ocean fertilization technologies may have potential land- and ocean-based impacts. Land-based impacts would be related primarily to the construction and operation of facilities to support ocean fertilization projects. Many of these impacts are expected to be site-specific in nature and associated with particular future demonstrations and implementation projects. These site-specific and project-specific impacts would be addressed in future NEPA and other environmental documents prepared for site-specific actions. Ocean-based impacts would be related to the methods and activities involved in the ocean fertilization process and their effects on marine ecosystems. As envisioned by the Program, ocean fertilization technologies and projects would be applicable to the high seas rather than to coastal waters. Therefore, the PEIS will assess the general range and types of potential impacts that can reasonably be expected to occur from ocean fertilization activities on the high seas.

Specific issues and impacts that the PEIS is expected to address and analyze include:

- ***Atmospheric Resources*** – Ambient air quality standards for criteria air pollutants (carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide) may be affected by emissions associated with construction and operation of supporting facilities for ocean fertilization projects, as well as by the methods used in the fertilization process.
- ***Aesthetic and Scenic Resources*** – Facilities constructed and operated to support ocean fertilization may affect scenic resources, vistas, and aesthetics in the vicinities of sites selected, as may the methods used in the fertilization process.
- ***Biological Resources and Protected Species*** – Potential impacts on terrestrial and marine vegetation, fish and wildlife habitats, and species protected under the Endangered Species Act and Marine Mammal Protection Act may be caused by the construction, operation, and maintenance of facilities and processes to support ocean fertilization. The methods used for ocean fertilization may cause changes in aquatic chemistry and affect populations of phytoplankton, zooplankton, vegetation, vertebrates, and invertebrates in marine ecosystems.
- ***Cultural Resources*** –Potential impacts on cultural resources may result from the construction of onshore facilities to support ocean fertilization projects, including effects on historic vistas caused by incompatible structures.

- ***Land Use*** – New onshore facilities needed to support ocean fertilization projects may affect land use. The potential for changes in commercial and industrial development patterns also may exist in areas considered suitable for ocean fertilization onshore support facilities.
- ***Materials and Waste Management*** – Potential impacts on materials and waste management would relate to possible increases in requirements for fuels, raw materials, and chemicals (solvents) and increases in the respective solid and liquid waste streams of onshore facilities and processes needed to support ocean fertilization projects.
- ***Human Health Effects and Safety*** – Health and safety concerns may result from onshore construction activities, the management of hazardous materials and chemicals, and process operations for support of ocean fertilization projects.
- ***Socioeconomics*** – Socioeconomic impacts may result from potential adverse effects on fishing (commercial and recreational) attributable to ocean fertilization practices. Potential environmental justice issues may be associated with the siting of onshore facilities to support ocean fertilization.
- ***Water Resources and Water Quality*** – Ocean fertilization practices may have impacts on water resources, including potential changes in aquatic chemistry that may affect marine ecosystems.

5.2.3 Sequestration – Terrestrial

Terrestrial sequestration would include technologies to enhance CO_2 uptake by terrestrial ecosystems.

Technologies

- Forestation and reforestation
- Agricultural practices to increase soil carbon
- Integration of fossil energy production and use with land reclamation and productivity

Context

- National
- Regional

Issues and Impact Areas

Impacts may result from changes in land management practices to promote terrestrial sequestration causing associated effects on air, water, and terrestrial ecosystems. Changes in land management practices that would involve land-disturbing activities or increase the use of materials and chemicals with the resulting potential for environmental releases (e.g., additional waste streams, air emissions, etc.) also may cause impacts. Many of these impacts are expected to be site-specific in nature and associated with particular future demonstrations and implementation projects. These site-specific and project-specific impacts would be addressed in future NEPA and other environmental documents prepared for site-specific actions. Potential impacts attributable to terrestrial sequestration technologies may occur in regions of the country where suitable lands are available for the implementation of these technologies. Therefore, the PEIS will assess the general range and types of potential impacts that can reasonably be expected

to occur from these types of activities in regions where the technologies are applicable, as well as any nationwide impacts.

Specific issues and impacts that the PEIS is expected to address and analyze include:

- ***Atmospheric Resources*** – The potential for increased releases of non-CO_2 greenhouse gases (e.g., methane, ammonia, nitrogen oxides) may occur as a result of terrestrial sequestration activities. Potential fugitive dust emissions may occur from changes in land management practices and agricultural uses to promote terrestrial sequestration.
- ***Aesthetic and Scenic Resources*** –Impacts on scenic resources, vistas, and aesthetics may occur as a result of changes in land management practices for terrestrial sequestration projects.
- ***Biological Resources and Protected Species*** – Changes in land management practices to support terrestrial sequestration (conversions of/to agricultural and forestry uses) may cause changes in vegetation and wildlife habitat, including impacts on species protected under the Endangered Species Act.
- ***Cultural Resources*** –The potential for impacts on cultural resources would be related primarily to land-disturbing activities and changes in land management practices, as well as to the effects on historic vistas caused by incompatible land management practices.
- ***Land Use*** – Changes in land use may be associated with land management practices to promote terrestrial sequestration (conversions of/to agricultural and forestry uses). The potential for changes in commercial and industrial development patterns also may exist in areas considered suitable for terrestrial sequestration.
- ***Materials and Waste Management*** – Potential impacts on materials and waste management would relate to possible increases in requirements for fuels, raw materials, and chemicals (solvents) and increases in the respective solid and liquid waste streams from activities related to terrestrial sequestration.
- ***Human Health Effects and Safety*** – Health and safety concerns may result from the management of hazardous materials and chemicals required for terrestrial sequestration practices. Unanticipated local health effects also may occur due to increased releases of non-CO_2 greenhouse gases (methane, ammonia, nitrogen oxides) as a result of terrestrial sequestration activities.
- ***Socioeconomics*** – Local impacts on crop production and forestry revenues may result from changes in agricultural or forestry uses and land management practices.
- ***Utility Infrastructure*** – Impacts may occur from the transportation of biomass, logging residues, etc. The utility demands attributable to changes in land management practices may also affect the utility infrastructure.
- ***Water Resources and Water Quality*** – Potential impacts on surface water runoff, water quality, and aquatic ecosystems may result from changes in land management practices and agricultural uses to promote terrestrial sequestration.
- ***Soils*** – Potential erosion and sedimentation impacts may occur from changes in land management practices and agricultural uses to promote terrestrial sequestration.

5.3 Monitoring, Mitigation, and Verification

Monitoring, mitigation, and verification (MMV) technologies would ensure that CO_2 is being stored effectively and safely by sequestration projects. MMV also would enable regulators to determine whether CO_2 reduction goals are being met and provide a basis for trading in credits for sequestered CO_2. Finally, MMV would provide essential feedback information for the refinement of sequestration practices.

Technologies:

- Advanced soil carbon measurement
- Remote sensing of above-ground carbon
- Detection and measurement of CO_2 in geologic formations
- Fate and transport models for CO_2 in geologic formations
- Other models and methods to be determined

Context

- In addition to the need for precise determination of long-term sequestration performance and leak rates, future carbon trading market requirements for quantifying stored volumes, validating ownership, and ensuring permanence of CO_2 reductions need to be addressed.

Issues and Impact Areas

The appropriate and effective implementation of MMV technologies would support the long-term observation of changes in environmental conditions associated with sequestration actions; hence, MMV would provide tools to assess the impacts of Carbon Sequestration Program actions. However, the implementation of MMV technologies may also have potential impacts related to the facilities, equipment, and procedures involved. Most of these impacts are expected to be site-specific in nature and associated with particular MMV efforts. These site-specific and project-specific impacts would be addressed in future NEPA and other environmental documents prepared for site-specific actions. The PEIS will assess the general range of potential impacts that can reasonably be expected to occur from MMV actions with consideration for national issues and regional differences where applicable.

Specific issues and impacts that the PEIS is expected to address and analyze include:

- ***Atmospheric Resources*** – MMV efforts are expected to provide data to help assess the long-term impacts on air quality from Program activities. Issues would be related to the determination of project boundaries and areas affected by respective sequestration actions.
- ***Aesthetic and Scenic Resources*** –Impacts on scenic resources, vistas, and aesthetics may occur based on the facilities, equipment, and procedures required to implement MMV efforts.
- ***Biological Resources and Protected Species*** – MMV efforts should provide data to help assess the long-term impacts on biological resources from Program activities. Potential impacts on vegetation and wildlife habitat, including impacts on species protected under the Endangered Species Act, may occur based on the facilities, equipment, and procedures necessary to implement MMV efforts.

- ***Cultural Resources*** –The potential for impacts on cultural resources would be related to land-disturbing activities necessary to implement MMV efforts, as well as to the effects on historic vistas caused by incompatible structures.
- ***Land Use*** – New facilities, equipment, and procedures required to implement MMV efforts may affect land use.
- ***Materials and Waste Management*** – Potential impacts on materials and waste management would relate to possible increases in requirements for fuels, raw materials, and chemicals (solvents) and increases in the respective solid waste streams of facilities, equipment, and procedures needed for MMV efforts.
- ***Human Health Effects and Safety*** – MMV efforts should support the identification of potential long-term hazards associated with respective sequestration projects, the assessment of probabilities of accidental leakage, including catastrophic releases, of stored CO_2, and the prediction of the magnitudes and effects of accidental leaks. Health and safety impacts may result from the management of equipment, hazardous materials, and chemicals associated with particular MMV efforts.
- ***Socioeconomics*** – Socioeconomic issues would be related to the establishment of a carbon commodity market with trading in verifiable CO_2 reduction credits. These issues emphasize the need for uniform MMV standards and protocols.
- ***Utility Infrastructure*** – The utility demands of facilities, equipment, and processes to reliably support MMV efforts may affect, or be affected by, the infrastructure for respective utilities.
- ***Water Resources and Water Quality*** – MMV efforts may provide data to help assess the long-term impacts on water resources from Program activities. Impacts on water resources, water quality, and aquatic ecosystems may result from spills or leakage of chemicals, solvents, dyes, or wastes from facilities and equipment needed to implement MMV efforts.
- ***Soils*** – Soils may be contaminated with chemicals, solvents, dyes, or wastes associated with facilities, equipment, and procedures necessary to implement MMV efforts.
- ***Geology*** – Issues may be associated with the reliability of MMV techniques for CO_2 migration in geologic formations.

5.4 Breakthrough Concepts

Breakthrough concepts would involve technologies for CO_2 capture and sequestration that are emerging from ongoing studies. These technologies are in a much earlier stage of development than geologic and terrestrial sequestration technologies. Therefore, the level of detail for the analysis of impacts must be tailored to the information available for these technologies.

Technologies

- Advanced CO_2 capture, including biochemical approaches and use of enzymes
- Bio-accelerated sequestration, subsurface
- CO_2 neutralization, subsurface
- Niches – circumstances where it is very easy or convenient to sequester carbon

Context

- National
- Regional (All - any region with large point source emitters)

Issues and Impact Areas

Potential impacts anticipated from the development, demonstration, and implementation of breakthrough technologies would be related primarily to the construction and operation of facilities (e.g., equipment, pipelines, utility corridors, etc.), industrial processes, the additional use of materials and chemicals, and the resulting potential for environmental releases (e.g., additional waste streams, air emissions, etc.). Many of these impacts are expected to be site-specific in nature and associated with specific future demonstrations and implementation projects. These site-specific and project-specific impacts would be addressed in future NEPA and other environmental documents prepared for site-specific actions. Potential impacts attributable to breakthrough technologies may occur in regions of the country where suitable conditions or unique systems are available for the potential implementation of these technologies. Therefore, the PEIS will assess the general range and types of potential impacts that can reasonably be expected to occur from these types of activities in regions where the technologies are applicable, as well as any nationwide impacts.

Specific issues and impacts that the PEIS is expected to address and analyze would be comparable to those described for capture, sequestration, and MMV. However, additional impacts may be associated with particular technologies that are attributable to special conditions (e.g., large energy requirements for certain concepts). The level of detail for the impacts assessment will be dependent upon the extent and detail of information available during preparation of the Draft PEIS.

5.5 Public Comments on Potential Technologies

Several comments indicated concern with respect to developing sequestration methods that would be cost-effective for the local economy. Other comments indicated strong skepticism regarding oceanic sequestration due to potential impacts on the CO_2 balances in the yet incompletely understood marine chemistry systems, while others generally favored geologic sequestration, contingent on groundwater impacts and the potential for leakage or sudden release of stored CO_2. Regarding terrestrial sequestration methods, concerns were expressed about afforestation and environmental impacts, such as degrading water quality and affecting biodiversity that would result with the loss of mature-growth forests. Several comments were directed specifically at DOE-NETL's "Carbon Sequestration Technology Roadmap and Program Plan – 2004," which was provided during the public scoping meetings. Comments are summarized below:

Table 4: Public Comments on Potential Technologies

Comment	How and Where Addressed in EIS
General Comments on Socioeconomic Impacts	
1. PEIS should include the potential socioeconomic impacts of the increased cost of energy as a result of CO2 capture and sequestration. Technologies should be economically feasible.	Chapter on Environmental Consequences The PEIS will include projections for the effects of CO2 capture and sequestration on the cost of energy.

Comment	How and Where Addressed in EIS
2. Major objective of Program should be to demonstrate and deploy technologies that can achieve environmental benefits and remain economically viable – thus, Program should maintain a level of flexibility that allows breakthrough concepts to be tested and verified.	Chapter on Environmental Consequences The PEIS will address the economic feasibility of technologies. The Program will provide flexibility to incorporate breakthrough concepts as they are tested and verified.
General Comments on Water Quality Impacts	
3. Concern with hydrogen and CO2 resulting in carbonic acid and effects on water resources.	Chapter on Environmental Consequences The PEIS will assess the potential impacts on water resources based on predicted emissions and anticipated chemical reactions, as practicable.
Carbon Capture	
4. Carbon capture must be done in concert with sequestration concepts as it does no good to capture it without having an environmentally benign place to put it.	Chapter on Proposed Action and Alternatives DOE anticipates that demonstration projects sponsored by the Program will involve coordinated capture and sequestration approaches. However, the PEIS recognizes the potential need to demonstrate technologies independently before they are deployed commercially.
Sequestration - General	
5. Sequestration is, in essence, a conservation issue. These activities should be viewed as an ecosystem restoration tool, with the express purpose of providing both carbon storage benefits and ecosystem restoration benefits.	Chapter on Environmental Consequences DOE acknowledges this recommendation.
6. When evaluating and developing recommendations relative to accounting rules, address the issues of additionality (carbon storage benefits accrued in addition to what would occur in the absence of a carbon project), leakage (migration of carbon emitting activities such as logging or land clearing to other areas outside the project area, effectively off-setting carbon sequestration benefits), permanence (duration of carbon storage methods) and verification (methods for measuring and verifying carbon sequestration benefits).	Chapter on Environmental Consequences DOE acknowledges this recommendation. The PEIS will evaluate these issues to the extent practicable based on available data, reasonable assumptions, and realistic projections.
7. When evaluating and developing recommendations relative to accounting rules, address the issue of scale. Scale refers to the land area that will be used to determine the baseline carbon storage capacity. The scale for programs should be of sufficient size to enable effective monitoring of additionality or leakage. At a minimum, carbon programs should be accounted for and reported at the county level.	Chapter on Environmental Consequences DOE acknowledges this recommendation. The PEIS will evaluate this issue to the extent practicable based on available data, reasonable assumptions, and realistic projections.
8. Carbon projects should be geospatially referenced to allow for GIS analyses utilizing remote sensing data and other technologies.	Chapter on Environmental Consequences DOE acknowledges this recommendation. The PEIS anticipates that the Program will incorporate GIS technology and remote sensing data where appropriate.
Terrestrial Sequestration	
9. Do not focus on tree planting because of the limited ability of such efforts to reduce CO2 emissions. DOE should not be a party to buying lands for growing commercial pine plantations as advocated by some because they take up CO2 faster than older trees. The Program should not be used as justification for logging and destroying older growth forests, which are important carbon sinks, and should not be disturbed or altered by human actions.	Chapter on Environmental Consequences DOE acknowledges this recommendation. The PEIS will address the potential benefits of preserving old-growth forests as a component of terrestrial sequestration. However, the PEIS will recognize that DOE does not have jurisdiction over land acquisition for preservation or forest management purposes.
10. DOE should look at a land acquisition program. Regarding afforestation, look at areas that already are protected - could use the initial buffer protection as high-quality land for other purposes, as well as for carbon sinks. Use this opportunity to acquire buffering lands.	See response to Comment 9 above.
11. DOE should not allow foresters to log trees due to so-called forest health concerns. Logging, burning, and windrowing of tree debris results in rapid decay and reduces huge amounts of CO2 quickly. Dying and natural decay allow for the storage and gradual release of CO2.	See response to Comment 9 above.

Comment	How and Where Addressed in EIS
12. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Page 12 – more advanced research for trees and grasses was proclaimed, but opposed to genetic engineering – impact is too great or too unknown.	Chapter on Environmental Consequences DOE acknowledges this comment. The PEIS will discuss the potential risks of genetic engineering to enhance desired metabolic traits and emphasize the need for thorough research before such methods are applied.
13. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Page 15, Table 4 (MMV row) – DOE needs to fly over and measure other types of forest other than just the Delta National Forest in Mississippi (relatively young). Other forests with other species that are dominant, and various ages including those with mature and older growth trees must be measured.	Chapter on Environmental Consequences DOE acknowledges this recommendation.
Geological Sequestration	
14. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan," - Page 9 – Geologic Sequestration – monitoring sequestration is contingent on finding all possible escape routes and either capping them or accounting for the losses of CO2 that they allow. Concerned with the thousands of oil/gas/water wells (capped/uncapped) – need very basic info to be gathered first before any storage area can be assessed.	Chapter on Environmental Consequences DOE acknowledges this comment. The PEIS will discuss the potential risks of CO2 releases from geologic sequestration formations and the need for appropriate data collection, planning, and monitoring.
15. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan," - Page 9 – benefits of using depleting oil reservoirs for sequestration and enhancing oil production should be offset with the fact that more oil will be used and emit CO2. The amount of CO2 and other air pollutants generated by burning this oil and its impacts on global warming must be addressed in PEIS.	Chapter on Environmental Consequences DOE acknowledges this comment. However, the PEIS will base future energy consumption on accepted Federal projections.
16. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan," - Page 14 – DOE needs to explain fully in PEIS how CO2 leaks would occur and how they would be capped or in other ways mitigated.	Chapter on Environmental Consequences See response to Comment 14 above.
17. Permanent and safe sequestration of carbon dioxide in geologic formations is not proven as a cost-effective mitigation option for carbon abatement.	Chapter on Environmental Consequences DOE acknowledges this comment. A purpose of the Carbon Sequestration Program is to prove or disprove this opinion.
18. Need to be able to detect leakage otherwise concerned with displacing brine and impairing the quality of potable water.	Chapter on Environmental Consequences The PEIS will discuss the potential risks of potable water contamination by displacement associated with CO2 injection into saline formations where respective aquifers may have permeable interfaces.
19. Because of the large scale/volumes of injection of CO2, concerned with effect on earth mechanisms on raising the land surface or consequences of increasing stresses	Chapter on Environmental Consequences The PEIS will discuss the potential risks to geomorphology associated with CO2 injection into geologic formations that may be unstable.
20. Can be successful, if done in a mass-balanced fashion, i.e., no incremental pressure. Should be done immediately with MMV, especially with trapped reservoir sequestration.	Chapter on Environmental Consequences DOE acknowledges this recommendation.
21. Need more demonstration projects for untrapped aquifers application to show environmental acceptability	Chapter on Environmental Consequences DOE acknowledges this recommendation.
22. Regarding regulatory permitting and safety framework for CO2 injection evolving on its own merit - the framework must not be inappropriately or inaccurately constrained by existing Underground Injection Control programs that were designed for unrelated activities.	Chapter on Environmental Consequences DOE acknowledges this recommendation.
Oceanic Sequestration	
23. Concern with disrupting ocean's production of oxygen.	Chapter on Environmental Consequences DOE acknowledges this comment. The PEIS will discuss the potential risks of ocean sequestration technologies and emphasize the need for thorough research before such methods are widely applied.

Comment	How and Where Addressed in EIS
24. Fertilizing the sea to make it fix more CO2 may disrupt its food web.	See response to Comment 23 above.
MMV	
25. When evaluating and developing recommendations relative to accounting rules, monitoring and evaluation should address not only carbon response, but also the ecological response. A monitoring and evaluation component for a program should be able to evaluate the following: 1) sequestration estimates and measurement; 2) baseline development; 3) leakage assessment; 4) permanence; 5) ecological benefits, including habitat restoration, water quality, flood storage, etc	See response to Comment 6 above.
26. Important issue for industry credit – could be giving industries credit when they don't deserve it; important to know what's staying in/out (leakage)	Chapter on Environmental Consequences DOE acknowledges this recommendation.
27. Analytical tools and methods must be demonstrated under conditions that reasonably represent actual field conditions for carbon sequestration.	See response to Comment 6 above.
28. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Page 15, Table 4 – MMV program must subtract the normal uptake of CO2 from the existing natural or human altered habitats so there will be a baseline CO2 reading	Chapter on Environmental Consequences DOE acknowledges this recommendation.
Breakthrough Concepts	
29. Regarding public scoping meeting's handout, "Carbon Sequestration Technology Roadmap and Program Plan" - Page 17, Table 5 – DOE states that it wants to create strains of microbes. Opposed to using genetic engineering to create any strains of microbes.	See response to Comment 12 above.

6. IMPACTS OF MAJOR INITIATIVES

Major Initiatives

- Collaboration with the National Academies of Science
- Regional Sequestration Partnerships
- MMV Program Initiatives

Technology Development Areas

- Capture
- Sequestration
- MMV
- Breakthrough Concepts
- Education and Outreach

Context

- National
- Regional

Issues and Impact Areas

Major initiatives identified and contemplated for the Carbon Sequestration Program cut across all technology development areas and geographic regions. Therefore, the issues and impacts

associated with respective major initiatives would correspond to the technology-related and regional issues and impacts as outlined for environmental resources in Section 3. Many of these impacts are expected to be site-specific in nature and associated with particular major initiatives. These site-specific and project-specific impacts would be addressed in future NEPA and other environmental documents prepared for site-specific actions. The PEIS will assess the general range and types of potential impacts that can reasonably be expected to occur from these types of major initiatives in regions where the technologies are applicable, while also evaluating any national effects from major initiatives.

Table 5: Public Comments on Impacts of Major Initiatives

Comment	How and Where Addressed in EIS
1. Regarding the middle school curriculum mentioned in the "Carbon Sequestration Technology Roadmap and Program Plan – 2004," what is the bias of this curriculum since someone will have to determine what he/she considers is a trade-off?	DOE acknowledges this comment. The PEIS will address the need for unbiased and balanced information in educational outreach programs.

7. OVERALL PROGRAM IMPACTS

The overall Program impacts would pertain to the cumulative impacts of major initiatives, development projects, and associated actions to be implemented over the life of the Carbon Sequestration Program. These issues and impacts would correspond to the technology-related and regional issues and impacts as outlined for environmental resources in Section 3. However, the PEIS would attempt to predict and evaluate the overall range and types of potential cumulative impacts that can reasonably be expected to occur from the planned implementation of the Carbon Sequestration Program in accordance with the targeted objectives and timetable for implementation. It is also recognized that there can be differences in potential cumulative impacts geographically from region to region of the United States due to regional differences in the intensity of point sources for CO_2 emissions, varying opportunities available for implementation of sequestration technologies and methods, and geographic differences in the extent and sensitivity of environmental resources to potential impacts.

Table 6: Public Comments on the Overall Program Impacts

Comment	How and Where Addressed in EIS
1. Concern that focus is in special industry. DOE must take necessary steps to make sure that objectives of reducing carbon are not hijacked by special interest groups	DOE acknowledges this recommendation.
2. Concern that huge technological fixes will encourage future use of fossil fuels.	See response to Comment 1 in Table 2 and response to Comment 15 in Table 4.
3. Examine how the Program will or will not promote the continued use of highly CO2-emitting fuels like coal, oil, and natural gas. EIS should document the impacts that an increase, reduction, or continued promotion of these fuels will have on the environment.	See response to Comment 1 in Table 2 and response to Comment 15 in Table 4.